

make special laboratory tests available to you.

VI. Observation of Monitoring

The employer is required to conduct monitoring that is representative of your exposure to benzene, and you or your designated representative are entitled to observe the monitoring procedure. You are entitled to observe the steps taken in the measurement procedure and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you or your representative must wear the protective clothing and equipment (See 46 CFR 197.575.)

VII. Access to Records

You or your representative may see the records of monitoring of your exposure to benzene upon written request to your employer. Your medical examination records may be furnished to you, your physician, or a representative designated by you. (See 46 CFR 197.570(c).)

VIII. Precautions for Safe Use, Handling, and Storage

Benzene liquid is highly flammable. Benzene vapor may form explosive mixtures in air. All sources of ignition must be controlled. Use non-sparking tools when opening or closing benzene containers. Fire extinguishers, where required, must be readily available. Know where they are located and how to operate them. Smoking is prohibited in areas where benzene is used or stored.

APPENDIX B TO SUBPART C OF PART 197—SUBSTANCE TECHNICAL GUIDELINES, BENZENE

I. Physical and Chemical Data

(a) *Substance identification.* (1) Synonyms: Benzol, benzole, coal naphtha, cyclohexatriene, phene, phenyl hydride, pyrobenzol. (Benzin, petroleum benzin, and benzine do not contain benzene).

(2) Formula: C₆ H₆ (CAS Registry Number: 71-43-2).

(b) *Physical data.* (1) Boiling point (760 mm Hg): 80.1 °C (176 °F).

(2) Specific gravity (water = 1): 0.879.

(3) Vapor density (air = 1): 2.7.

(4) Melting point: 5.5 °C (42 °F).

(5) Vapor pressure at 20 °C (68 °F): 75 mm Hg.

(6) Solubility in water: .06%.

(7) Evaporation rate (ether = 1): 2.8.

(8) Appearance and odor: Clear, colorless liquid with a distinctive sweet odor.

II. Fire, Explosion, and Reactivity Hazard Data

(a) *Fire.* (1) Flash point (closed cup): -11 °C (12 °F).

(2) Autoignition temperature: 580 °C (1076 °F).

(3) Flammable limits in air, % by volume: Lower: 1.3%, Upper: 7.5%.

(4) Extinguishing media: Carbon dioxide, dry chemical, or foam.

(5) Special fire fighting procedures: Do not use a solid stream of water, because it will scatter and spread the fire. Fine water spray may be used to keep fire-exposed containers cool.

(6) Unusual fire and explosion hazards: Benzene is a flammable liquid. Its vapors can form explosive mixtures. All ignition sources must be controlled when benzene is used, handled, or stored. Areas where liquid or vapor may be released are considered hazardous locations. Benzene vapors are heavier than air. Thus, benzene vapors may travel along the deck and ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.

(7) Benzene is classified as a flammable liquid for the purpose of conforming to the requirements of 49 CFR 172.101 concerning the designation of materials as hazardous materials. Locations where benzene may be present in quantities sufficient to produce explosive or ignitable mixtures are considered Class I Group D locations for the purposes of conforming to the requirements of 46 CFR parts 30 through 40, 151, and 153 when determining the requirements for electrical equipment as specified in Subchapter J (Electrical engineering).

(b) *Reactivity.* (1) Conditions contributing to instability: Heat.

(2) Incompatibility: Heat and oxidizing materials.

(3) Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide).

III. Spill and Leak Procedures

(a) *Steps to be taken if the material is released or spilled.* As much benzene as possible should be absorbed with suitable materials, such as dry sand or earth. That remaining must be flushed with large amounts of water. Do not flush benzene into a confined space, such as a sewer, because of explosion danger. Remove all ignition sources. Ventilate enclosed places.

(b) *Waste disposal method.* Disposal methods must conform to state and local regulations. If allowed, benzene may be disposed of (a) by absorbing it in dry sand or earth and disposing in a sanitary landfill, (b), if in small quantities, by removing it to a safe location away from buildings or other combustible sources or by pouring onto dry sand or earth and cautiously igniting it, and (c), if in large

quantities, by atomizing it in a suitable combustion chamber.

APPENDIX C TO SUBPART C OF PART
197—MEDICAL SURVEILLANCE GUIDE-
LINES FOR BENZENE

I. Route of Entry

Inhalation; skin absorption.

II. Toxicology

Benzene is primarily an inhalation hazard. Systemic absorption may cause depression of the hematopoietic system, pancytopenia, aplastic anemia, and leukemia. Inhalation of high concentrations may affect the functioning of the central nervous system. Aspiration of small amounts of liquid benzene immediately causes pulmonary edema and hemorrhage of pulmonary tissue. There is some absorption through the skin. Absorption may be more rapid in the case of abraded skin or if it is present in a mixture or as a contaminant in solvents which are readily absorbed. The defatting action of benzene may produce primary irritation due to repeated or prolonged contact with the skin. High concentrations are irritating to the eyes and the mucous membranes of the nose and respiratory tract.

III. Signs and Symptoms

Direct skin contact with benzene may cause erythema. Repeated or prolonged contact may result in drying, scaling dermatitis or development of secondary skin infections. In addition, benzene is absorbed through the skin. Local effects of benzene vapor or liquid on the eye are slight. Only at very high concentrations is there any smarting sensation in the eye. Inhalation of high concentrations of benzene may have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation, or giddiness, followed by a period of depression, drowsiness, or fatigue. A sensation of tightness in the chest accompanied by breathlessness may occur and ultimately the victim may lose consciousness. Tremors, convulsions, and death may follow from respiratory paralysis or circulatory collapse in a few minutes to several hours following severe exposures.

The detrimental effect on the blood-forming system of prolonged exposure to small quantities of benzene vapor is of extreme importance. The hematopoietic system is the chief target for benzene's toxic effects which are manifested by alterations in the levels of formed elements in the peripheral blood. These effects may occur at concentrations of benzene which may not cause irritation of mucous membranes or any unpleasant sensory effects. Early signs and symptoms of benzene morbidity are varied. Often, they are not readily noticed and are non-specific.

Complaints of headache, dizziness, and loss of appetite may precede or follow clinical signs. Rapid pulse and low blood pressure, in addition to a physical appearance of anemia, may accompany a complaint of shortness of breath and excessive tiredness. Bleeding from the nose, gums, or mucous membranes and the development of purpuric spots (small bruises) may occur as the condition progresses. Clinical evidence of leukopenia, anemia, and thrombocytopenia, singly or in combination, may be among the first signs.

Bone marrow may appear normal, aplastic, or hyperplastic and may not, in all situations, correlate with peripheral blood forming tissues. Because of variations in the susceptibility to benzene morbidity, there is no "typical" blood picture. The onset of effects of prolonged benzene exposure may be delayed for many months or years after the actual exposure has ceased. Identification or correlation with benzene exposure must be sought out in the occupational history.

IV. Treatment of Acute Toxic Effects

Remove from exposure immediately. Make sure you are adequately protected and do not risk being overcome by fumes. Give oxygen or artificial resuscitation, if indicated. Flush eyes, wash skin if contaminated, and remove all contaminated clothing. Symptoms of intoxication may persist following severe exposures. Recovery from mild exposures is usually rapid and complete.

V. Surveillance and Preventive Considerations

(a) *General.* The principal effects of benzene exposure addressed in 46 CFR part 197, subpart C, appendix A, are pathological changes in the hematopoietic system, reflected by changes in the peripheral blood and manifested clinically as pancytopenia, aplastic anemia, or leukemia. Consequently, the medical surveillance program specified in 46 CFR 197.560 is designed to observe, on a regular basis, blood indices for early signs of these effects. Although early signs of leukemia are not usually available, emerging diagnostic technology and innovative regimes are making consistent surveillance for leukemia, as well as other hematopoietic effects, more and more beneficial.

Initial and periodic medical examinations must be provided as required in 46 CFR 197.560. There are special provisions for medical tests in the event of hematologic abnormalities or emergencies.

The blood values which require referral to a hematologist or internist are noted in 46 CFR 197.560(d) (i), (ii), and (iii). That section specifies that, if blood abnormalities persist, the employee must be referred unless the physician has good reason to believe that the referral is unnecessary. Examples of conditions that might make a referral unnecessary despite abnormal blood limits are iron